Notice of Allowability	Application No.	Applicant(s)	
	09/541,399	WU ET AL.	
	Examiner	Art Unit	
	William H. Wood	2124	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *18 June 2004*.

2. ☒ The allowed claim(s) is/are *14-17,19-23 and 40-69*.

3. ☒ The drawings filed on *31 March 2000* are accepted by the Examiner.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Michael Anglin on 02 September 2004.

The application has been amended as follows:

Claim 40 (renumbered 10)

A computer-implemented method comprising:

- dividing the control flow graph (CFG) ~~CFG~~ of a program into a plurality of hierarchical regions, at least some of the regions having multiple entry nodes and/or multiple exit nodes;
- selecting one or the regions;
- replacing an inner region with respect to the selected region by a representative node;
- adding source and sink nodes to the CFG of the one region;
- if the one region has multiple entry nodes, adding an edge from the source node to all the entry nodes of the one region;
- if the one region has multiple exit nodes, adding an edge from all the exit nodes of the one region to the sink node;

- assigning identifiers to the edges in the one region, including the added edges so as to produce a unique combination of the identifiers for each path in the region, including paths from the source node and to the sink node.

Claim 49 (renumbered 19)

A computer-readable ~~machine-readable~~ medium bearing instructions executable by a computer for carrying out the method of:

- dividing the control flow graph (CFG) ~~CFG~~ of a program into a plurality of hierarchical regions, at least one of the regions having multiple entry nodes and/or multiple exit nodes;
- selecting one or the regions;
- replacing an inner region with respect to the selected region by a representative node;
- adding source and sink nodes to the CFG of the one region;
- if the one region has multiple entry nodes, adding an edge from the source node to all the entry nodes of the one region;
- if the one region has multiple exit nodes, adding an edge from all the exit nodes of the one region to the sink node;
- assigning identifiers to the edges in the one region, including the added edges so as to produce a unique combination of the identifiers for each path in the region, including paths from the source node and to the sink node.

Claim 50 (renumbered 20)

A computer-implemented method comprising:

- generating a control flow graph (CFG) ~~CFG~~ of a program for profiling, the program having a number of existing edges, a function entry node, and a function exit node;
- dividing the CFG into multiple hierarchical regions comprising outer and inner regions each having at least one region entry node and at least one region exit node;
- selecting representative paths within the regions;
- inserting additional edges into the CFG to produce an augmented CFG, at least one of the edges extending between an outer one of the regions and an inner one of the regions;
- assigning edge identifiers to the existing edges and to at least some of the additional edges such that any path, including paths through the some additional edges, in the augmented CFG has a unique combination of edge identifiers.

Claim 67 (renumbered 37)

A computer-readable ~~machine-readable~~ medium bearing instructions executable by a computer for carrying out the method of:

- generating a control flow graph (CFG) ~~CFG~~ of a program for profiling, the program having a number of existing edges, a function entry node, and a function exit node;
- dividing the CFG into multiple hierarchical regions comprising outer and inner regions each having at least one region entry node and at least one region exit node;
- selecting representative paths within the regions;
- inserting additional edges into the CFG to produce an augmented CFG, at least one of the edges extending between an outer one of the regions and an inner one of the regions;
- assigning edge identifiers to the existing edges and to at least some of the additional edges such that any path, including paths through the some additional edges, in the augmented CFG has a unique combination of edge identifiers.

Claim 68 (renumbered 38)

A computer-readable ~~machine-readable~~ medium bearing instructions executable by a computer for carrying out the method of:

- generating a control flow graph of a program, the graph having an inner region with multiple entry nodes and defining prolog and epilog nodes, and an outer region;

- selecting a single one of the existing entry nodes as a representative entry node for the inner region;
- replacing the inner region with the representative entry node;
- for each prolog node of the inner region having an edge to one of the existing entry nodes other than the representative entry node, adding an edge from the prolog node to the representative entry node; and
- for each epilog node of the inner region, adding an edge from the representative entry node to the epilog node;
- assigning edge values to all edges in the control flow graph such that the sum of the edge values along each unique path is unique within the control flow graph.

Claim 69 (renumbered 39)

A computer-readable ~~machine-readable~~ medium bearing instructions executable by a computer for carrying out the method of:

- in a control flow graph, selecting a representative path within an inner region, having entry and exit nodes that define prolog and epilog nodes, of a software function having a function entry and a function exit, the representative path being identified by a single entry node selected from among multiple existing entry nodes of the inner region, and a single representative exit node selected from among multiple existing exit nodes of the inner region;
- adding an edge from the function entry to each entry node of the inner region;

- adding an edge from each exit node of the inner region to the function exit;
- for each prolog node of the inner region having an edge to one or the existing entry nodes that is not the representative entry node, adding an edge from the prolog node to the representative entry node; and
- for each epilog node of the inner region having an edge to one of the existing exit nodes that is not the representative exit node, adding an edge from the representative exit node to the epilog node; and
- assigning edge values to all edges in the control graph such that the sum of the edge value along each unique path is unique within the control flow graph.

Allowable Subject Matter

Claims 14-17, 19-23 and 40-69 are allowed.

The following is an examiner's statement of reasons for allowance: the combined limitations of the independent claims are not taught or fairly suggested by the prior art of record singly or in a properly motivated combination. Claim 14 provides for generating a control flow graph of a program having an inner region and an outer region; selecting a single one of the existing entry nodes as a representative entry node for the inner region and replacing the inner region with the representative entry node; for each prolog node of the inner region having an edge to one of the existing entry nodes other than the representative entry node, adding an edge from the prolog node to the representative entry node and for each epilog node of the inner region, adding an edge from the representative entry node to the epilog node; in conjunction with assigning edge values to all edges in the control flow graph such that the sum of the edge values along each unique path is unique within the control flow graph. The prior art of record does not teach singly nor provide a clear motivation for combining the teachings thereof, especially assigning edge values to a *modified* control flow graph as described. Additional independent claims provide for limitations reciting hierarchical regions with representative nodes and assigning unique identifiers for path identification (see claim 40 and also claims 23, 49, 50, 67-69). Thus, the independent and all dependent claims are allowable over the prior art of record.

The prior art of record, **Breternitz, Jr.** et al., **Tenev** and **Bharadwaj** and **Muchnick**, provided modified node structure of control flow graphs as previously

indicated. However, they do not disclose the assigning step as claimed in Applicant's independent claims. Thus, in view of the prior art of record, the claims are allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to William H. Wood whose telephone number is (703)305-3305. The examiner can normally be reached 7:30am - 5:00pm Monday thru Thursday and 7:30am - 4:00pm every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kakali Chaki can be reached on (703)305-9662. The fax phone numbers for the organization where this application or proceeding is assigned are (703)746-7239 for regular communications and (703)746-7238 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)305-3900.

William H. Wood
September 6, 2004

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